

## Chairman's Introduction

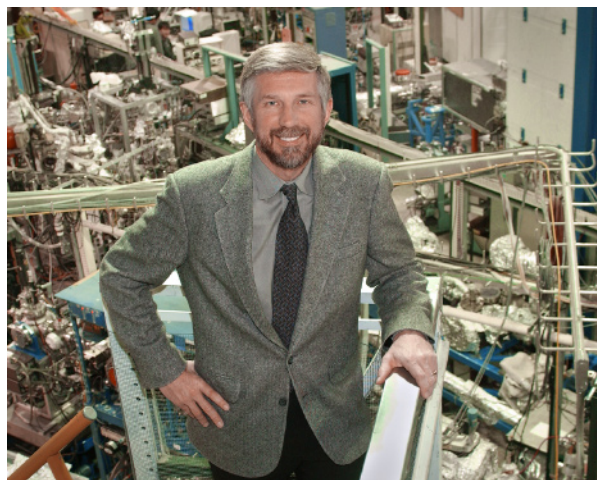
Steve Dierker

CHAIRMAN, NATIONAL SYNCHROTRON LIGHT SOURCE

The scientific productivity of the NSLS continues to be outstanding and the research conducted here has high impact. 2003 was no exception and some of the many highlights from this year's research activity are included in this Activity Report. We are especially pleased that one of our users, Professor Roderick MacKinnon (Rockefeller University), was the co-recipient of the 2003 Nobel Prize in Chemistry for work, much of which was done at the NSLS, explaining how proteins known as ion channels help to generate nerve impulses. It is also a particular pleasure to note that NSLS accelerator physicist Li Hua Yu was awarded the 2003 International Free Electron Laser Prize in recognition of his outstanding achievements, especially demonstrating High Gain Harmonic Generation (HGHG) at the DUV-FEL.

Our vision for the NSLS in the next five to 10 years is for it to continue to serve as a vital resource for the nation and especially for the strong Northeast research community. To accomplish this, we are working to preserve and enhance its outstanding scientific productivity by providing increased user support and upgrading beamline and endstation instrumentation. For example, this past year we collaborated with scientists from the Albert Einstein College of Medicine and the BNL Biology Department to develop a new undulator beamline, X29, to meet the needs of macromolecular crystallography for high brightness x-rays. A new endstation on the undulator beamline X13B is being equipped with optics and instrumentation for microdiffraction and microprobe experiments. The wiggler beamline, X21, is being upgraded to provide high intensity and increased capacity for small angle x-ray scattering experiments on nanotemplated soft matter, biomaterials, and other systems. We are collaborating with the BNL Center for Functional Nanomaterials to develop a beamline for LEEM/PEEM studies, which will add important new capabilities for nanoscience and catalysis research. A new high-speed, high-resolution curved position sensitive detector for powder diffraction was also developed and made available to users to enable time-resolved studies of reaction mechanisms, phase transformations, chemical kinetics, and material dynamics. At the DUV-FEL, this past year saw the achievement of HGHG light at 266 nm, with a substantial third harmonic at 89 nm. User science experiments were initiated and published in Physical Review Letters and a successful workshop was held to identify the new scientific opportunities in the chemical sciences enabled by this unique light source. These and many other important projects are described more fully in the Facility Report.

However, in spite of these efforts, the capabilities of the present NSLS are increasingly limiting the productivity of its user community. Continually updated over more than 20 years, with brightness several orders of magnitude higher than the initial design value, the performance of



*Steve Dierker*

the NSLS has reached its theoretical limit - its brightness cannot be increased significantly beyond its current value, and its eight-fold periodicity severely limits the number of insertion devices. Over the past two years we have engaged the user community in an extensive dialogue to answer the question, "What science will users do in 10+ years and what will they need to do it?" While predicting the future is always difficult, the user community responded enthusiastically, and in more than two dozen workshops (13 in 2003 alone) they identified the future 'grand challenge' problems in the fields of life science, nanoscience, materials and chemical sciences, geoscience, and environmental science. The clear result is that, in order for the legendary productivity of the NSLS to continue, and to tackle the 'grand challenge' problems of tomorrow, it is essential that the NSLS be upgraded to provide much higher average brightness and flux.

To provide these capabilities, we submitted a proposal to the Department of Energy (DOE) for NSLS-II, a new National Synchrotron Light Source at BNL. Our initial proposal was reviewed in February 2003 by a DOE Basic Energy Sciences Subcommittee, convened as part of the process of formulating the 20-year facilities plan, and later released by the DOE. Recognizing the continued need for third generation x-ray sources, the subcommittee recommended that we work with DOE to formulate a plan for a new third generation ring to replace the current NSLS; now NSLS-II is one of the facilities listed on the 20-year DOE facilities plan. After collecting additional input from the user community and refining our concept, we will submit a full proposal describing the scientific opportunities enabled by NSLS-II, and its pre-conceptual design, in March 2004. NSLS-II will be a highly optimized, third generation medium energy storage ring with full energy injection for top-off mode operation. The x-ray brightness and flux of NSLS-II will be world leading and will be 10,000 times brighter and have 10 times more flux than the present NSLS across the energy spectrum from  $\sim 10$  eV up to  $\sim 20$  keV. The present VUV/IR ring will be relocated to the new facility to serve as a dedicated IR ring, which will provide world-leading brightness and flux in the important near- to far-IR spectral region.

Access to these new capabilities and the unique infrastructure envisioned for the new facility will have profound impact on a wide range of scientific disciplines and initiatives and lead to many exciting discoveries in the coming decades. NSLS-II will enable structural studies of the smallest crystals in structural biology and provide a wide range of nanometer resolution probes for nanoscience. It will make possible coherent beam scattering studies of the dynamics of condensed matter systems in an otherwise inaccessible regime of low frequencies and short length scales. It will introduce new methods for imaging the structure of biological systems and disordered materials, and greatly increase the applicability of inelastic x-ray scattering. The superlative character and combination of capabilities of NSLS-II will serve the cutting edge science of the nation, and will have a particularly dramatic impact as a vital resource for the strong academic and industrial research community of the Northeast United States.

Thus, our vision for NSLS in the next 10 to 30 years is to enable grand challenge science by providing world-leading capabilities. NSLS-II will accomplish this goal.



NSLS-II is a proposed new advanced third generation medium energy storage ring designed to deliver world leading brightness and flux with top-off operation for constant output. The facility will be able to produce x-rays up to 10,000 times brighter than those produced at the NSLS today.